Massachusetts and Rhode Island, where there was very little. The greatest amount for the month was 30 inches, at Patten, Me. There were no prolonged and destructive gales and no great delay to shipping from stress of weather. There were no storms without warnings.—*J. W. Smith, District Forecaster.*

NEW ORLEANS FORECAST DISTRICT.*

[Louisiana, Texas, Oklahoma, and Arkansas.]

Temperature was generally below the normal, and, except over eastern portions of Louisiana and Arkansas, precipitation was deficient. Frost warnings were issued on eleven dates, and warnings were issued for all frosts that occurred in the apple-growing section of Arkansas. High winds occurred over the interior on the 6th and 30th, forecasts for which were issued on the previous dates, and strong winds occurred along the Gulf coast on a few dates, for which warning had, as a rule, been issued.—*I. M. Cline, District Forecaster.*

LOUISVILLE FORECAST DISTRICT.*

[Kentucky and Tennessee.]

With the exception of two quite warm periods, the 4–6th and 16th–21st, unusually cold weather predominated, with frequent frosts in the first and last decades of the month. Frost warnings were issued on seven occasions, but damage was confined mostly to the first decade. Precipitation was in excess, and over much of Kentucky it was nearly double the normal amount. There were four rain periods and many thunderstorms, a number of which were attended by violent wind squalls and excessive rains. There was also considerable destruction by lightning. The storm of the 29–30th was of unusual severity and the damage by wind and water extensive. —*F. J. Walz, District Forecaster.*

CHICAGO FORECAST DISTRICT.*

[Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas, and Montana.]

Precipitation was above the average over the eastern half and below normal over the western section of the district, while temperature was quite generally below the average, the deficiency in the Northwest being considerable. Storms crossed the district with great frequency, causing the excess of rainfall above referred to in the eastern section. Four of the storms were attended by high winds. The first reached the Lake region the night of the 6th and crossed it during the 7th. Storms also crossed the Lakes during the 11–12th, 21st, 29–30th. The usual advices were sent to open ports in connection with the first storm mentioned, and storm warnings were ordered after the 10th, when the storm-warning season began. Frost warnings were issued for several days for Illinois, Indiana, Missouri, and Kansas, and when exceptionally low temperatures seemed imminent for the Northern States special forecasts for temperatures of freezing or below were made.—*H. J. Cox, Professor and District Forecaster.*

DENVER FORECAST DISTRICT.*

[Wyoming, Colorado, Utah, New Mexico, and Arizona.]

Except in southern portions of Arizona and New Mexico, the weather was cooler than usual. Precipitation was in excess in north-central and northwestern Colorado and deficient in other portions of the district. In southern New Mexico and southern Arizona no rain fell. Following the passage of areas of low pressure, the weather was decidedly cold over the greater portion of the district on the 5–8th, 11–12th, 20th–23d, and 29–30th. On the morning of the 30th a destructive frost occurred in Wyoming, Utah, Colorado, and northern portions of New Mexico and Arizona. All important weather conditions were covered by the forecasts.—*P. McDonough, Local Forecaster.*

SAN FRANCISCO FORECAST DISTRICT.†

[California and Nevada.]

The month was abnormally dry. No storms crossed the State from the ocean and there were no southerly extensions of North Pacific low areas. Unusually warm weather prevailed over southern California at the beginning of the month. A few thunderstorms were reported in the mountain districts on the 28th. There were no frost nor storm warnings issued during the month—*Alexander G. McAdie, Professor of Meteorology.*

PORTLAND, OREG., FORECAST DISTRICT.†

[Oregon, Washington, and Idaho.]

The month was cool and dry, with frequent frosty mornings. Warnings were issued for practically all the frost that occurred. The interest taken in frost warnings is constantly increasing and more smudging was done this year than ever before. There are still, however, large fruit sections in the district where no attempt is made to protect the crops from frost by any of the methods in vogue. A new method of smudging, which consists of placing a large number of small pots in the orchard and burning crude petroleum in them, has been tried. Fires thus produced make a dense smoke and heat to some extent the surrounding air, and it is claimed that the plan has been very successful.—*E. A. Beals, District Forecaster.*

RIVERS AND FLOODS.

The month was characterized by the usual seasonal floods east of the Mississippi River, but none of them was in any way marked, except in portions of New England, where warm rains and melted snow and ice on the 6th and 7th caused a decided rise in all the rivers, with considerable resulting damage. Flood stages were general along the Connecticut River, with a crest of 19.1 feet, 3.1 feet above flood stage, at Hartford, Conn., on the 10th. Similar conditions on the 13th and 14th caused a second and more pronounced rise, with a crest stage of 24.7 feet at Hartford, on the 17th. All the tributary streams in northern New Hampshire, northern Vermont, and western Maine were in flood, and much damage of the usual character resulted. Warnings were issued whenever possible, and through them a large amount of portable property was saved. Warnings were also issued during the latter half of the month for the moderate floods in the Susquehanna and James rivers. The damage was insignificant, and property to the amount of $10,000 was saved along the James River.

Over the Black Warrior and lower Tombigbee watersheds heavy rains from the 22d to the 27th, inclusive, were followed by a flood of considerable proportions, beginning on the 26th and continuing through the early days of the following month. On the 1st day of May the stage of the river at Demopolis, Ala., was 50 feet, 15 feet above flood stage, with a further rise of 1.2 feet indicated. The first warnings were issued on the 24th, and supplementary ones frequently thereafter. The losses amounted to about $40,000, about equally divided between crops and suspension of farm and other work. To the lumber interests the flood was very welcome, as it permitted the movement of a large quantity of logs. Losses by erosion were offset by alluvial deposits. The value of property saved through the Weather Bureau warnings was about $200,000.

In the Pearl and Pascagoula rivers the floods were more moderate, with losses amounting to about $12,500, and property saved to the value of about $10,000.

Nothing of special interest occurred along the three great rivers of the interior. There was a moderate flood in the Mississippi River in the vicinity of Hannibal, Mo., beginning on April 12 and lasting well into May, but little or no damage resulted. A sharp rise set in over the upper Ohio and tributaries on the last day of the month, and on the morning of May 1 a moderate flood was in progress.

ICE.

No ice was reported on the 11th day of the month, when the Penobscot River opened at Mattawamkeag, Me. The Connecticut River at Wells River, Vt., opened on the 5th, and the

* Morning forecasts made at district center, night forecasts made at Washington, D. C.

† Morning and night forecasts made at district center.

Missouri River at Wolf Point, Mont., and the Mississippi River at Fort Ripley, Minn., on the 6th.

The highest and lowest water, mean stage, and monthly range at 216 river stations are given in Table VI. Hydrographs for typical points on seven principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—*H. C. Frankenfield, Professor of Meteorology.*

SPECIAL ARTICLES, NOTES, AND EXTRACTS.

THE CLOUDS OF VENUS AND THEIR SIGNIFICANCE.[1]

By ARTHUR W. CLAYDEN, M. A.

If it be assumed that the visible surface of Venus is the outer face of a heavily cloud-laden atmosphere, comparable in mass and composition with our own, it seems that certain deductions may be based on its observed features which have not hitherto been pointed out, though they convey valuable hints as to the planet's physical condition, the position of its axis, and the period of rotation.

There is no need to recapitulate here the many reasons for believing that the surface visible to most telescopes is actually cloud, and the sequel will show that such a view is not incompatible with the detection of sharp markings such as have been described by specially favored observers. My own observations have been made with the 6.8 inch refractor by Tully, described in Vol. II of the Society's Memoirs. Its long focus (144 inches) gives excellent definition of Jupiter and Saturn, when the seeing is good, with powers up to 450; but it has never shown me anything on Venus which does not seem easily explicable on the assumption that the planet is shrouded in clouds, and that its atmosphere bears something like the same relation to its mass as our own atmosphere does to the earth's.

Taking this for granted, let us consider how those clouds should be distributed according to different views as to the period of rotation and the position of the polar axis.

LONG ROTATION PERIOD.

First let us assume that the axis makes a large angle with the plane of the orbit, and that the period of rotation is coincident with the revolution. That is to say, that the planet always turns the same face to the sun—one side always exposed to the solar glare, and the other feeling the full effect of continuous radiation into space.

In this case, even allowing for considerable libration, it is more than difficult to imagine how the clouds are maintained on the sunlit face at all. The whole of the water should long ago have been distilled on to the dark side, and there locked up in the form of ice. It seems impossible that there should be an atmospheric circulation capable of keeping up a high enough temperature on the cold hemisphere to allow of the return to the hot one of a sufficiently large amount of water to produce the clouds. We can not call to our aid a circulation of water in the liquid state, for rivers are dependent upon rainfall or thawing ice, and the very seas should have been distilled. A slow glacial creep seems the only possibility, and that could hardly suffice to do more than produce a ring of cloud along the terminator, leaving the greater part of the hot hemisphere to stand out naked to the sunshine and to our view. Moreover, the phenomena seen along the terminator show no symptoms of great and rapid movements of the atmosphere, such as should certainly be the case if the continuity of a reasonable balance of temperature, and therefore of humidity, were dependent even indirectly upon them.

It may be contended with some reason that the great pall of clouds will moderate the temperature of the sunlit face, but this hemisphere must, on the whole, be one of rising convection currents, while the dark side must conversely be one of descending currents. Descending movements mean clear skies, and therefore unchecked radiation; so, whatever the initial temperature of the dark face may have been when last shut off from the sun's heat, it can not have been protected by a blanket of cloud, and must be intensely cold.

The assumption of a high internal temperature is no more satisfactory, for the same causes which should have frozen the water should have previously chilled the solid rocks, and have thereby placed a thick protecting shield between the hot interior and the frozen surface. If we allow for the difference in the internal pressures, the densities of Venus and the earth are so near as to imply not only identity of composition but a close similarity of condition.

It seems that the only way in which the persistence of the cloudy envelope could be explained, would be to assume a thermal conductivity for the mass of the solid planet far higher than that of the materials of the earth.

In the absence of any such extravagant and improbable supposition, it thus appears that the continued existence of the cloudy shell affords an almost conclusive negative to the possibility of an exact identity between rotation and revolution.

SHORT ROTATION PERIOD.

Next, suppose the axis to make a large angle with the plane of the orbit, and that the rotation period is not very different from the length of a terrestrial day.

In this case it is at once obvious that the distribution of temperature on the planet should be strictly similar to that on the earth. The actual values might be everywhere higher, but the gradients should be in precisely the same directions. Of course the local variations due to the distribution of land and water would differ, but the broad differences due to latitude and the time of day should present an exact parallel.

Moreover, the laws of motion which govern the movements of our atmosphere, and combine with the results of the temperature gradients to determine the general arrangement of atmospheric pressure and the great wind systems, must inevitably produce effects on the somewhat smaller planet, just like those which dominate the meteorology of the earth.

The region of ascending or cloud-producing currents must be similarly distributed, and the descending or cloud-destroying currents must occupy the same relative places.

The result should be a belt of uprising currents surrounding the planet's equator at its equinoxes, and moving more or less toward each pole in turn with the progress of the seasons. North and south of this, at about the latitude of 20° or 30°, there should be a belt of higher pressure, and therefore of descending motion, while farther away from the equator toward each pole the chief drift of the atmosphere should be tangential and moving with the rotation.

There should therefore be a shining white belt over the equatorial low pressure, flanked on either side by a band where clouds should be small and scanty, and therefore much less brilliant. Then again, brighter regions should extend to each pole.

Moreover, such a circulation should give rise to storms analogous to our own, moving over the planet in the same way, and their courses should often be clearly visible.

The earth must show all these features so plainly that they would be the first thing noticed. Except in the region of our tropical belts of high pressure an astronomer on Venus would

[1] Reprinted, by permission, from the Monthly Notices of the Royal Astronomical Society, January, 1909, 69:195–204, and accompanied by illustrations [Chart IX] from sketches by the author.